I. C. 6898 AUGUST 1936

DEPARTMENT OF THE INTERIOR

UNITED STATES BUREAU OF MINES
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COSTS OF TRUCKING AND PACKING ORE IN WESTERN GOLD-MINING DISTRICTS

BY

E. D. GARDNER

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COSTS OF TRUCKING AND PACKING ORE IN WESTERN GOLD-MINING DISTRICTS 1/

By E. D. Gardner 2/

INTRODUCTION

Ore and concentrate are transported on the surface at western mining districts by (1) railroads, (2) surface trams, (3) aerial trams, (4) trucks, and (5) wagons, and (6) on the backs of animals.

The daily and ultimate tonnage to be moved is the principal factor governing the selection of the method of transportation. Railroads are preferred when large tonnages are to be hauled over relatively long distances. The mine-haulage system may be extended or surface trams built to the mill or shipping point if a practical track grade is possible and if the distance is relatively short. Aerial trams have a special field of usefulness for transportation over steep or excessively rough terrain.

Trucks generally are used in preference to teams, except on very poor or unusually steep roads or in mountainous regions of heavy snowfall. Ore usually is packed on animals only as the last resort.

The most common method of transporting ore from the mine to the mill in western gold mining is by trucks for distances of 1 mile or more. Trucks also are used for shorter distances; in one case it was found more economical to use a truck where the haul was only 1/4 mile than to tram the ore by hand. Packing is used only for transporting relatively small tonnages where there are no passable roads. If any considerable amount of ore is to be mined, a road or an aerial tramway is usually built.

1/ The Bureau of Mines will welcome reprinting of this paper provided the following footnote acknowledgment is used: "Reprinted from U. S. Bureau of Mines Information Circular 6898."

2/ Supervising engineer, Metal Mining Methods Section, Mining Division, U. S. Bureau of Mines.

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PART I. - TRUCKING

The cost of trucking is governed by the condition of the roads, length of haul, regularity of shipments, and the capacity and fitness of the trucks used. On long hauls, relatively less time is taken to load and unload the trucks, hence, lower ton-mile costs are obtained. Moreover, distance has a further bearing on costs in that the cost of trucking would be less at a mine where the last of a number of round trips would be just completed at the end of a shift than at a property where the length of haul was such that the time of making a trip could not be divided evenly into the number of hours in a shift. Costs are substantially lower when equipment can be employed steadily than when the hauling is intermittent.

Two popular makes of trucks, each with a rated capacity of 1-$\frac{1}{2}$ tons, are used in more instances for hauling gold ore or concentrate in the western mining districts than trucks of any other one size. These 1-$\frac{1}{2}$-ton trucks commonly haul 4-ton loads and occasionally are loaded up to 6 tons. For hauling overloads, the trucks are equipped with "helper springs" and oversize dual tires. Three-and-one-half-ton trucks, on which loads up to 7 tons are hauled, are the next most numerous for this service. Trucks with a rated capacity up to 12 tons are used, but in relatively fewer numbers. Some of the long-distance trucking is done by commercial highway trucking companies, which generally use large trucks.

The life of a small truck, when regularly and heavily overloaded, is shorte than that of a larger one with a rated capacity more nearly equal to that of the loads actually hauled. Moreover, the upkeep of the smaller trucks is higher. The purchase of the cheaper small trucks is justified, however, where there may b doubt as to the duration of a hauling job. Lighter trucks are used more commonly for relatively short trips and heavier ones for long-distance hauling. Some contractors prefer light trucks for crooked roads, as better time can be made with them.

Trucks with four-wheel drive are used on roads with steep grades. One make of truck is reported to be able to go up a maximum grade of 40 percent when empty. In the summer of 1934, a truck with four-wheel drive was used in hauling concentrate from the Mattie mill at Idaho Springs, Colo. The first half mile below the mill had an average grade of 25 percent. Ordinary passenger cars could not negotiate the hill.

Ore usually can be transported long distances in carload lots cheaper by rail than by trucks. The railroad rate increases with the grade of the ore; with very high-grade material, trucking may be less costly than shipping by rail. The freight rate on less than carload lots usually is more than for trucking. Moreover, shipping ore or concentrate by truck has an advantage in that any size lot may be marketed. With equal rates, shipping carload lots by rail usually is preferred to contract trucking. The routine for paying for lost shipments and the railroad's financial ability to pay losses has been well-established; many small trucking contractors would have difficulty in paying for a lost lot of high-grade ore or concentrate.

Teams seem to be preferred for hauling ore over rough roads with steep grades for relatively short distances and in regions of heavy snowfall. The cost of teaming, however, for longer distances over steep, rough roads may be about the same as for trucking. For instance, ore was hauled by teams from the Paymaster mine to Townsend, Mont., in the summer of 1933, a distance of 30 miles, for $3.50 per ton. The roads were passable for trucks for part of the year, but the cost of the upkeep of the trucks made this form of hauling more expensive. Usually, however, if very much hauling is to be done the roads are improved and trucks used.

The difficulty of trucking increases as snow begins to fall. On well-traveled highways the roads are kept open, and trucks can be used throughout the year. On less-traveled roads, in regions of heavy snowfall, trucks cannot be used in the winter. Teams and pack animals are used for hauling 10 tons of concentrate daily from the Camp Bird mine to Ouray, Colo. The concentrate is packed on mules 3 miles and is then hauled 6 miles in two wagons with four-horse teams. One round trip is made daily with the wagons. The contract price is $6 per ton from the mine and $9 for the back haul. The $6 includes loading the concentrate in railroad cars when a shipment has been accumulated. Doubtless the ore could be trucked more cheaply over the lower six miles during the summer, but as horses and wagons were required for winter work they were used the year around by the contractor.

Trucking of supplies from Grangeville, Idaho, to the Gnome mine at Oro Grande, Idaho, a distance of 59 miles, cost $10 per ton in the summer and $15 in the winter. A part of the way was improved, and the rest was ordinary mountain road. When the roads were bad the load was transferred from an ordinary truck at the halfway point to a truck with dual wheels and a four-wheel drive. The final 5 miles was made by sleigh.

A total of 3,600 tons of freight was taken 54 miles from the railhead over snow to the Sherritt-Gordon[3] mine in 1930; 19 miles was over portages and 36 miles over frozen lakes. The portages were not graded. Tractors with a train of sleighs were used; the cost was $0.27 per ton mile. During the previous winter, 2,600 tons were taken 80 miles at a cost of $0.56 per ton-mile. At the peak, 150 teams and 4 tractors were in use.

During the winter of 1934-35, supplies were hauled to the Bussieres mine in Quebec, a distance of 26 miles, on snow over frozen muskeg in sleds pulled by a tractor at a cost of $6 per ton or $0.23 ton mile, according to Chas. F. Jackson, chief engineer, Mining Division, Bureau of Mines. The time of making a trip one way ranged from 5 to 48 hours.

Trucking of ore and concentrate at most small mines in the West is done on contract. Contractors usually can quote rates lower than the cost of doing the work on company account. This is especially true if the same trucks can be used concurrently on several jobs. Moreover, the mining companies are saved the purchase price of the necessary equipment.

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[3] Canadian Institute of Mining and Metallurgical Engineers, History, Development, and Production Plans at Sherritt Gordon Mines: Trans. vol. 33, 1930, pp. 245-271.

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A single contractor hauled 260 tons daily (the mill capacity) to the Katherine mill in Mohave County, Ariz., from four or five different mines. The distance ranged from 4 to 12 miles and the cost per ton mile from 5 to 9 cents. He used five 3-1/2-ton trucks, loaded with 7 tons each, and two 1½ ton trucks, on which 3 to 4 tons were hauled. One driver for each truck and a mechanic were employed. The trucks were run one shift, ranging from 10 to 14 hours daily; occasionally one or more trucks would be run an extra shift, in which case the contractor would drive one truck and, if needed, an extra driver would be hired. The cost per mile would be appreciably higher should the hauling from each mine be done independently.

Costs of trucking

The costs of trucking in western gold-mining districts are given in tables 1, 2, 3, 4, 5, and 6. The prices shown are contract prices unless otherwise specified. Table 1 contains the rates for moving about 450 tons daily to three milling plants in the Oatman and Katherine districts in northern Arizona and occasional carload lots from neighboring districts to the railroad.

The costs per ton-mile as ordinates and length of haul in miles as abscissas are plotted on figure 1. Curve A shows the relation of cost per mile ton to length of haul when a definite daily tonnage is handled over good dirt roads; the trucks are loaded from chutes, dumped into bins, and are steadily employed. Curve B shows the higher costs at three mines where the roads are in poorer condition or where the ore is shoveled into the trucks. Table 2 contains further costs in Arizona districts. California costs are given in table 3.

Figure 2 shows the relation of costs per ton-mile plotted against length of haul for long-distance hauling on highways in Arizona and California. The data are taken from tables 2 and 3. Considerable merchandise is moved out of Los Angeles, San Francisco, and El Paso by highway trucking companies. The low rates shown in the tables and on the curve for distances of 300 miles or more are made possible by the desire of these trucking companies to obtain freight for a return haul in trucks that otherwise would be unloaded.

In the summer of 1935 California trucking companies, in order to use idle equipment, were willing to take contracts to transport 50 tons or over daily for distances of 199 miles or more for $0.03 per ton-mile; no return-haul freight was to be expected. These low rates probably could not be expected if the trucks could be used full time for hauling general merchandise.

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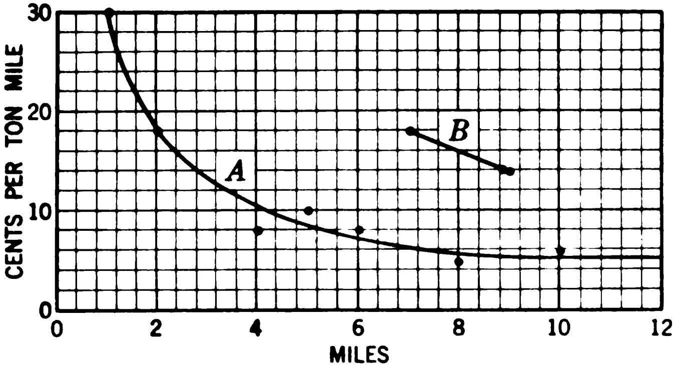

Figure 1.—Curve *A*. Ore-trucking costs, Oatman and Katherine Districts, Arizona. Sustained tonnages are hauled over good dirt roads with no shoveling. Curve *B*. Same as *A*, except that the roads are poorer or the ore is shoveled into the trucks.

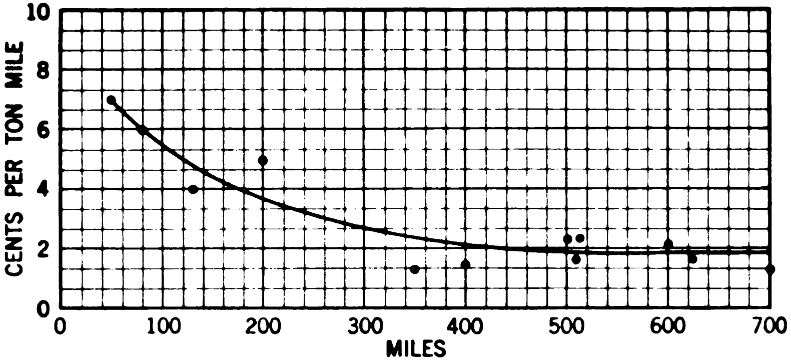

Figure 2.—Costs of trucking ore and concentrate long distances in irregular small lots in California and Arizona.

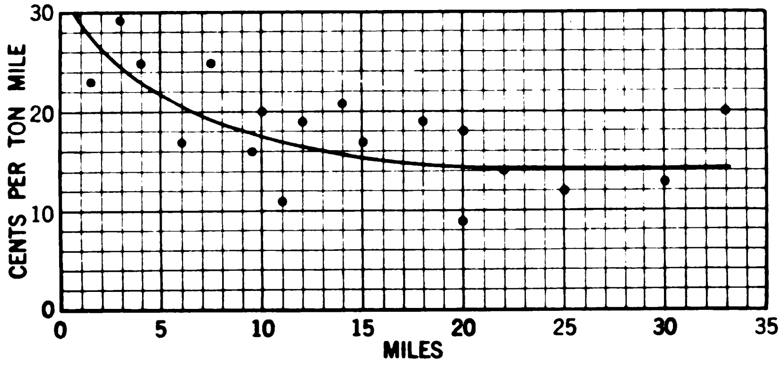

Figure 3.—Ore-trucking costs, Nevada; mostly fair dirt roads and irregular lots.

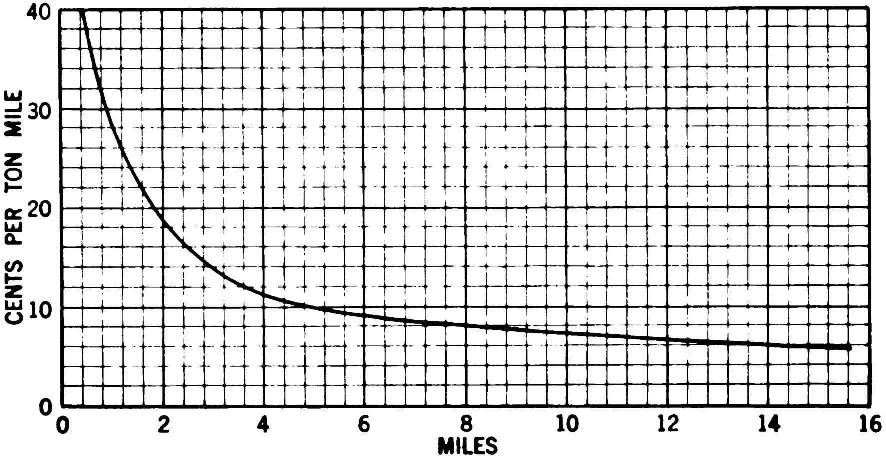

Figure 4.—Rates of trucking regular tonnages of ore over good dirt roads where trucks can be employed steadily and with no shoveling in or out under conditions existing in northwestern Arizona and California.

TABLE 1. - Trucking costs in Arizona

From -	To -	Distance, miles	Tons, daily	Year	Condition of road	Shoveling	Size loads tons	Price per ton 1/	Cost per ton-mile	Remarks
Oatman District:										
Big Jim mine	Telluride mill	1	45	1933	Good	None.	7	$ 0.30	$ 0.30	
Ruth-Rattan mine	Tom Reed mill.	9	40	1935	Fair	do.	7	1.25	.14	
Mossback mine	do.	9	....	1934	do.	do.	7	1.25	.14	
German-American mine	do.	4 to 5	15	1935	do.	do.	7	.50	.10	
Do.	do.	4 to 5	15	1935	do.	In...	7	.75	.15	
Midnight mine	do.	7	2	1935	Good	do.	7	1.25	.18	
United Western mine	do.	2	20	1935	Excellent	None	7	.35	.18	
Katherine District										
Tyro mine	Katherine mill	6	60		Fair	do.	7	.50	.08	3-$\frac{1}{2}$-ton trucks loaded to 7 tons.
Roadside mine	do.	4	2/	1935	Good	do.	7	.30	.08	do.
Arabian mine	do.	8	2/	1935	do.	do.	7	.40	.05	do.
Portland mine	do.	15	2/	1935	Fair	do.	7	1.12	.07	do.
Frisco mine	do.	10	2/	1935	Good	do.	7	.60	.06	do.
River Range:										
Klondyke mine	Tom Reed mill.	82	15	1935	Fair	In....	7	5.00	.06	
Eldorado mine	do.	75	......	1935	Good	do.	7	6.00	.08	Odd lots
Pope mine	Kingman R. R. station.	53	......	1935	do.	do.	7	3/ 3.50	.07	50-ton lots
Pilgrim mine	Midvale, Utah.	515	......	1935	Excellent	......	.....	15.00	.03	Odd lots, concentrate, sacks.

1/ All hauling done by contract unless otherwise specified.

2/ Some contractor did all hauling to Katherine mill (total 250 tons daily).

3/ This includes $2 per ton highway tax in Utah. New rate after new road built across dam, which eliminates curves and hills, $11, exclusive road tax.

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Table 2. - Trucking costs in Arizona

From -	To -	Distance, miles	Tons, daily	Year	Condition of road	Shoveling	Size loads, tons	Price per ton	Cost per ton-mile	Remarks
Keystone, Kingman	Los Angeles	350	3	1935	Excellent	......	......	$5.00	0.014	Back-haul in highway trucks.
Do............	San Francisco	700	3	1935	do.	......	......	8.50	.012	do.
Lelan-Divide-Mayer.......	Clarkdale..	51	.....	1936	Good.....	In.....	......	4.50	.09	33-ton lot.
Swastika mine..	Mayer......	23	.....	1936	Fair.....	In and out	......	4.00	.17	Concentrate, car lots.
Richinbar mine.	do......	19	.....	1936	do....	...do..	......	3.50	.18	do.
Golden Turkey mine........	do.......	15	5	1936	Good.....	do..	......	2.00	.13	Company account.
Golden Belt, Mayer.......	El Paso, Tex.	510	3 1/3	1936	Highway..	Sacked	......	1/ 8.15	.016	Concentrate
Oro Flame mine.	Prescott....	10	.....	1934	Good 2/	do..	5	3/ .60	.06	Concentrate, car lots.
Davis-Dunkirk mine........	do.......	16	.....	1935	Fair.....	do..	3 and 6	4/ 3.00	.19	do.
Tillie Starbuck mine........	Davis-Dunkirk mill....	1 1/2	25	1934	do....	In.....	6	1.00	.67	Shovel from dump, some sorting.
Verde Central mine........	Jerome......	2	55	1931	Good.....	None...	10	5/ .25	.12	Company account.
Golden Slipper mine........	Hot Springs Junction.	13	.....	1934	Fair.....	In and out..	......	1.37	.11	Car load lots.
Humbug mine....	Morristown..	50	.....	1934	Rough....	Sacked.	7	5.00	.10	Concentrate, 7-ton lots.
Morristown.....	El Paso, Tex.	500	.....	1934	Highway..	do..	7	12.00	.024	do.
Gold King......	Tucson......	70	.....	1933	Fair.....	In and out..	7	7.50	.11	100-ton lots.
Montana........	Sahuarita...	40	24	1931	do....	do..	6/ 12	4.50	.11	Company account.
Mammouth mine..	Mohawk mill.	3	50	1933	do....	In.....	.....	.25	.08	....
Dos Cabesos....	Wilcox......	14	.....	1935	do....	In and out..	.....	2.50	.18	Intermittent 40-ton lots.

1/ Taken by highway trucking firm as backhaul to Phoenix, then used to round out loads of bulky material to El Paso. 2/ 1 mile very rough and steep, three trips daily. 3/ On company account; does not include depreciation or major repairs. 4/ First 1-1/2 miles rough, up 1,500 feet vertical; 3 tons only hauled to divide. 5/ Does not include depreciation. 6/ With trailer, round trip 16 hours.

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TABLE 3.- Trucking costs in California

From -	To -	Distance, miles	Tons, daily	Year	Condition of road	Shoveling	Size loads, tons	Price per ton	Cost per ton-mile	Remarks
Banner mine, Nevada City..	Lava Cap mill	2	75	1935	Fair.....	None..	5	$0.35	$ 0.175	....
Hoge mill, Nevada City....	Selby smelter	130	2	1935	Excellent	In and out	.....	5.00	.04	6-ton lots.
Easy Bird mine, Mokelumne Hill....................	Easy Bird mill	1/4	80	1935	Good.....	None..	3 1/2	.10	.40	1-1/2-ton truck.
Easy Bird mill............	Jackson	13	3	1935	do....	In and out	.....	2.00	.15	Concentrate; 6-ton lots.
Alpine mine, Georgetown...	Beebe mill....	3	60	1935	do....	None..	.....	.44	.15	....
Montezuma mill............	Eldorado......	8	6	1935	Excellent	In and out	.....	1.10	.14	Concentrate; carload lots
Middle Butte mine, Mojave.	Tropico mill..	9	25	1936	Good.....	None..	.....	1.00	.11	....
Rogers and Gentry, Neenach	do.......	34	8	1935	do....	do..	.....	1.70	.05	....
Golden Bee mine, 29 Palms.	do.......	200	2	1935	Fair.....	In....	.....	10.00	.05	15-ton lots.
Branch mine, Victorville..	do.......	75	....	1935	Good.....	do..	5	3.50	.05	5-ton lots.
Silver Queen mine.........	Mojave........	2	40	1935	Poor.....	Out...	.....	1.00	.50	....
King Solomon mine, Randsburg..............	King Solomon mill.....	2	17	1935	Fair.....	None...	.....	.17	.085	Company account; no depreciation.
Big Blue mine, Kernsville.	Big Blue mill.	3/4	115	1935	do....	do...	12	.20	.26	....
Big Blue mill.............	Selby.........	400	....	1935	Excellent	In and out.	.....	6.00	0.015	Concentrate
Cardinal mill, Bishop.....	Laws, Nevada..	20	4	1934	Fair.....	do..	.....	2.50	.125	Concentrate; carload lots.
Old Pete mine.............	Ludlow........	4	40	1934	do....	None..	.....	1.00	.25	....
Gold Coin Apex mine, Needles................	Selby.........	625	....	1935	Excellent	Out...	6	10.00	.016	12-ton lots.

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The company that operated the Tropico custom mill (table 3) trucked ore from outlying mines to its mill at a flat rate of $0.05 per ton-mile for distances of over 20 miles.

The dirt roads in the Arizona and California districts covered in this paper seldom are muddy; moreover, there is almost a complete absence of snow. Trucking costs would be higher than those included in the tables if it were necessary to contend with mud or snow. In most of the long-distance hauls shown in the tables, the trucking rates are equal to or less than railroad freight tariff. For example, the cost of transporting concentrate in sacks from the Golden Belt mine near Mayer, Ariz., to El Paso, Tex. (table 2), a distance of approximately 500 miles, is $8.15 per ton. The smelting company makes an extra charge of $0.50 for handling sacked concentrate. An adjoining mine ships approximately the same grade of concentrate without sacking in carload lots to El Paso by freight at a cost of $7.85 per ton from Mayer; the trucking cost from the mine to Mayer is $2.00 per ton. In this case the cost by trucks is less, but with lower grade concentrate a saving would be made in shipping by freight.

Trucking costs in Nevada are shown in table 4. The costs per ton mile are plotted against length of haul in figure 3. The curve shows a general decline in costs per ton mile as the distance is increased. Data as to road conditions, regularity of shipments, and whether the loads were shoveled in or out are largely lacking.

Trucking costs in Colorado, Utah, and New Mexico are given in table 5, and for Montana, Idaho, and Oregon in table 6.

TABLE 4. - Trucking costs in Nevada[1]

From -	To -	Distance, miles	Tons, daily	Year	Condition of road	Shoveling	Size loads, tons	Price per ton	Cost per ton-mile
Divide	Tonopah	6		1935	Good			$ 1.00	$ 0.17
Peters mine	Mina	12	2	1935				2.25	.19
Ashby mine	do.	20	2	1935				1.75	.09
Brown Palace mine	Sulphur	8		1935				2.00	.25
Do.	Seven Troughs	30		1935				4.00	.13
Eureka-Croesus mine	Eureka	4	4	1935				1.00	.25
Gold Bar mine	Beatty	11		1935				1.25	.11
McCrea mine[2]	End Truck road	1/2	2	1935	Uphill	In and out	3/4	1.75	3.50
End Truck Road mine	Carrara	20		1935				3.50	.18
Capicorn mine	Beatty	22		1935				3.00	.14
Gibralter mine, Carrara	Gibralter mill	2-1/2	40	1934			5	.40	.16
Copper Basin mine	Battle Mountain	9-1/2		1935				1.50	.16
Plumas mine	do.	15		1935				2.50	.17
Tomboy mine	do.	14		1935				3.00	.21
Copper Mountain mine	do.	18		1935				3.50	.19
Last Chance mine	do.	10		1935				2.00	.20
Gold Dome mine	do.	33		1935				6.50	.20
Little Gem mine[3]	Beowawe	25		1935				3.00	.12
Blossom mine	Searchlight	3	10	1935	Fair	In and out	3	1.00	.33
Ely Gold mine	Ely	1-1/2	50	1935	do.	None	5	.35	.23

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[1] Data supplied by W. O. Vanderburg, associate mining engineer, Reno, Nev., except last two items.

[2] In 3-wheel motorcycle with box.

[3] Contract, recent company, cost $1.10 per ton.

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TABLE 5. - Trucking costs in Colorado, Utah, and New Mexico

From -	To -	Distance, miles	Tons daily	Year	Condition of road	Shoveling	Size loads, tons	Price per ton	Cost per ton-mile	Remarks
Colorado:										
Perrin mine.....	Blackhawk.....	3	10	1934	Fair	None	......	$0.70	$ 0.23	....
Mattie mill.....	Idaho Springs	3-1/2	5	1934	1/	In	6-1/2	1.50	.43	4 wheel drive trucks, carload lots.
Grand Republic mine........	St. Joe mill, Boulder	7	50	1934	Fair 2/	In 3/	3-1/3	1.50	.21	3 new $1,000 1-½ ton trucks.
Cold Springs mine.........	do.......	7	25	1935	do 2/	do 3/	3-1/3	1.50	.21	do.
Slide mill.......	Boulder.......	18	4-1/2	1934	Good	In and out	......	1.75	.10	Concentrate; carload lots.
Orpha May mine..	Cripple Creek	1/2	40	1935	Fair	1/2 in.	......	.40	.80	....
Lease, Stratton mine.........	do.......	1	40	1935	do.	In.	......	.50	.50	....
Veneer mine.....	Leadville.....	1/2	25	1935	do.	In and out	5	1.00	2.00	....
South London mine.......	do.......	87	15	1934	Good	do.	......	4.07	.05	Concentrate
Gold King mine..	Hesperous.....	22	......	1934	do.	Out...	......	2.00	.09	Company account.
Utah:										
Clementine mine.	Midvale......	8	......	1934	Excellent	In and out ..	......	1.50	.19	8-ton lot.
Yankee mine.....	American Fork	13	50	1934	Fair	None...	......	1.12	.09	....
Palmer mine.....	Gold Hill.....	1-1/2	12	1934	do.	Out....	12	.75	.50	$0.50 per ton extra for loading into box cars.
Cane Springs....	do.......	1/2	......	1934	do.	In and out..	12	.50	1.00	Odd carload lots.
Buckskin Mountains.....	Cedar City...	130	......	1934	Good.	do.	......	12.00	.09	Odd lots.
Copperhead mine.	Delta.........	30	......	1934	Poor.	Out....	4	2.25	.075	One 100-ton lot; contractor lost money.
New Mexico:										
Crow-Strom mine.	Silver City..	11	......	1933	Fair.	In and out..	......	1.00	.09	40-ton lots.
Cactus mine.....	Vanadium.....	70	......	1933	Good	do.	10	2.50	.036	do.
Bonanza mine, Hillsboro..	El Paso, Tex.	125	......	1933	do.	do.	......	5.00	.04	Concentrate.

1/ One-half mile rough road, 25 percent grade; rest road good. 2/ All running in low or second gear; up 1,000 and down 1,500 feet. 3/ Mining company furnishes one man to assist truck driver to load.

TABLE 6. - Trucking costs in Montana, Idaho, and Oregon

From -	To -	Distance, miles	Tons, daily	Year	Condition of road	Shoveling	Size loads, tons	Price per ton	Cost per ton-mile	Remarks
Montana:										
Gold Coin mine.	Gold Coin mill, Silver Lake	1/2	14	1933	Fair	In.....	......	$0.50	$ 1.00	Open-cut; driver helps load.
Do............	do.......	1/2	7	1933	do.	None...	......	.35	.70	Loaded from chute.
Rock Creek.....	Anaconda.......	125	.....	1933	1/	In.....	......	8.00	.06	Odd lots.
Southern Cross.	do.......	20	10	1933	Excellent	None...	......	1.50	.08	....
Jewell Lease...	Butte..........	1	.....	1933	Good	In and out.	......	1.00	1.00	10-ton lots.
Garnet.........	Bearmouth......	11	.....	1933	Fair	do.	......	2.00	.18	Occasional carload lots.
Do............	do.......	13	.....	1933	do.	2/...	......	3.00	.23	do.
Jardine mill...	Gardiner.......	6	6	1933	Good	Out....	......	1.50	.25	Carload lots
Idaho:										
Atlanta mill...	Mountain Home..	85	10	1934	Fair; steep	....	......	14.00	.16	Sacked concentrate, 5 months per year.
Champlain mine, Haily......	Champlain mill.	7	25	1934	Fair	In.....	......	1.00	.14	....
Oregon:										
Quartzburg mine	Baker..........	80	.....	1933	Good	do..	5	6.00	.08	Carload lots.

1/ 106 miles highway, 12 miles fair, 7 miles very poor.

2/ Hauled 1 mile over ridge then transferred to another truck.

The individual items making up the costs shown in the tables are largely lacking; most of the figures were supplied by the mining companies to which this information was not available. The classified costs in one instance for truckin from the lower terminal of the aerial tramway of the Yankee mine (table 5) to th railroad, a distance of 12 miles, follow:

	1932	January 1933
Labor........	$0.27	$0.21
Supplies.....	--	.59
Miscellaneous	.85	.32
Total	$1.12	$1.12

The items for "Miscellaneous" contain service expenditures for road repairs.

Summary of Costs

The costs of trucking vary widely in different sections of the country, as shown in the tables. The costs depend mainly upon the condition of the roads, length of haul, daily tonnage handled, and regularity of the shipments. The roads to many small mines are unimproved; this condition is directly reflected in the relatively higher costs in many instances shown. As production increases, more work usually is done on the roads, which, together with more regular shipments, results in lower costs.

The costs of trucking regular tonnages of ore over good dirt roads where the trucks can be steadily employed and with no shoveling in or out under conditions existing in gold mining districts in northwestern Arizona and California in 1935 may be summarized as follows:

Distance, miles	Cost per ton-mile
Up to 1	Average $0.35
1 to 2	" .22
2 to 5	" .12
5 to 10	" .09
10 to 20	" .06
20 to 100	" .05

The curve in figure 4 shows the same generalized costs. The rates for hauling over poor roads or of irregular or small lots would, of course, be much higher. About $0.35 per ton divided by the miles hauled should be added to the above figures for each time the ore is shoveled.

PART II. - PACKING

Ore is transported on the backs of animals when relatively small tonnages of high-grade material are handled down steep mountain sides or over rough country where no roads exist. When any considerable tonnage is to be handled, roads usually are built and either wagons or trucks are used.

Burros are used largely for packing ore in the Southwest and mules elsewhere in the West. Burros can find their own food and may be obtained cheaply in the desert mining regions. Ownerless animals are a nuisance in some Arizona mining districts. Mature burros weigh 400 to 600 pounds and may be purchased at from $2.50 to $10 each, or ownerless animals may be rounded up on the desert.

Mules carry heavier loads and usually cover greater distances per day than burros. When used steadily, mules are fed, the cost of feeding them being higher than that of feeding a burro. A burro withstands the summer heat in the desert better than a mule. Pack mules weighing about 800 pounds cost from $35 to $50; those weighing 900 to 1,000 pounds cost from $100 to $125. Heavier mules are used seldom as pack animals.

The size of the load that an animal can carry and the distance that can be covered per trip depend upon the steepness and roughness of the trails. Burros commonly carry as much as 285 pounds down steep but fair trails for distances up to 2-1/2 miles. The maximum load for a 5-mile trip is 250 pounds; the usual load, however, is 200 pounds. For all-day trips the usual load is about 150 pounds per burro. Daily round trips usually are 5 to 8 miles each way; one-way trips with the animals loaded are from 10 to 14 miles long. Mexican contractors frequently supply isolated camps with wood. A cord of dry pine (600 to 800 pounds) usually is packed on four burros for several miles.

Because of the work involved in loading and unloading, packers usually do not unload the animals until the end of a trip. When this procedure is followed, considerably longer distances can be traveled in a day. A prospector in the Galuiro Mountains of Arizona periodically covers 25 miles to Klondyke in a day with a string of 10 large burros, each loaded with 150 pounds of ore. He unloads, waters, and rests the animals at noon. He rides a burro also. The animals could not make the trip regularly; the above performance is unusual. Usually 20 miles would be considered a good day's journey under similar circumstances.

Strong mules can carry up to 420 pounds each for 3 or 4 miles. Usually, however, the load per mule is not over 300 pounds, except for very short distances. Average mules are loaded with 200 to 250 pounds for trips of 5 or 6 miles, with lighter loads for longer distances. Usually they carry about 175 pounds on all-day trips. Round trips loaded one way usually are 10 to 14 miles each way; one-way trips, loaded, are 14 to 20 miles. By unloading and resting the animals enroute, 200 pounds may be carried 20 or 25 miles each day.

Mules seldom are loaded with more than 200 pounds each when used for packing supplies, and longer distances are traveled in a day than when ore is being packed.

Horses are used largely in the Northwest for packing supplied to small properties away from roads. Usually they are loaded with 150 to 200 pounds and are good for about the same distance as a mule. Horses must be better fed than mules and cost more to keep. Moreover, they cannot stand the work as well as mules.

The loads that can be carried and the distances that can be traveled per day will, of course, depend upon the size and physical condition of the animals used. The burros used in the Southwest average about 500 pounds in weight, but there is considerable difference in the size of pack mules used throughout the country. The size of loads carried has a bearing on the ease with which pack animals can be handled. A fractious animal usually becomes docile when loaded heavily.

Although burros with relatively light loads can be turned loose and driven by a man on foot, only heavily loaded mules can be handled in this manner. Unless trained for the work, each mule or horse in a pack string is tied to the one ahead, the leader generally being led by a mounted man.

The hand labor of saddling, loading, and unloading the animals is responsible for a large part of the cost of packing. Usually one man can handle a strin of 5 to 7 pack animals and two men can handle 10 to 15.

At the Humbug mine about 70 miles from Wickenburg, Ariz., burros were used to bring ore to the mill from vein outcrops over steep rough country with no trails. Usually 1 ton was loaded on 7 animals, but in very rough country 8 to 10 animals would be used. Five round trips, averaging 1 mile each way, were made daily. Two men with saddle horses handled a string of 10 burros. The work was done on company account, and the animals were fed. Three bales of hay and a small amount of grain were fed daily. The cost of feed was about $0.35 daily per burro. Feed, shoeing, and repairing of gear cost about $0.50 daily per animal.

Near Prescott, Ariz., in 1934, a man afoot with eight burros made three round trips of 1-1/4 miles each way daily. A ton was hauled to the load. He earned $6 daily. The animals were turned loose at night to graze.

At the Camp Bird mine in Colorado, two men with saddle horses manage a string of 28 to 30 selected mules, which is about twice the usual number. The packing work is systematized, efficient gear is used, and loading and unloading platforms minimize the physical labor of handling the material. Moreover, the lead saddle horse, to which the first mule in the string is tied, has been trained to start and stop the pack animals at command at the terminals, which leaves both men free to attend to the loading and unloading. Two round trips of 3 miles each way are made daily over a good trail. The loading point is at an elevation of about 12,000 feet, and the point of delivery is 1,500 feet lower down. Ten tons of concentrate in bags holding about 70 pounds each are handled daily. Each mule is loaded with six bags (400 to 420 pounds), except a few small animals, which are loaded with five sacks. The two men tend the stock and do all the shoeing. In addition, mill and mine supplies are carried on some of the return trips. The maximum load uphill is 200 pounds per animal.

In packing crude ore two boxes, one on each side, generally are fitted to the pack saddle on each animal. The boxes can be dumped without being removed from the animal. They may be loaded while on the animal or filled on the ground and then raised into place. In the latter case, two men are required to load. In some localities, however, where enough packing has to be done to justify the expenditure, the animals may be led under a chute for loading the boxes.

Concentrate generally and ore occasionally is sacked for animal transportation. This practice is always followed when the material is to be handled more than once in transit.

The same type of pack saddle is used in most districts, but the gear used with the saddles varies greatly in different sections of the country. The proficiency of packers also varies greatly. An expert packer with proper equipment can load a string of animals in half the time that is taken by a less-experienced man.

Although on ordinary roads ore can be hauled more cheaply in wagons than by packing, the latter method seems to have an advantage for relatively small tonnages on very steep roads, particularly in regions of heavy snowfall. Loads can be brought down much steeper grades with pack animals than in wheeled vehicles; moreover, where the snowfall is heavy and the winter long, packing over the whole year may be cheaper than the combined cost of hauling and keeping the roads clear of snow. This is true at the Camp Bird mine. Trucks with four-wheel drives can be taken to this mine from the camp site during about four months, and ordinary trucks can be taken from the railroad to the camp site during six months of the year. Pack animals going over a trail each day keep the snow packed. Likewise, but to a less extent, roads can be kept open with teams; snow plows are needed to keep roads open for trucks or automobiles at high elevations in most of the mountainous regions in the West.

When the surface is smooth, ore can be dragged down a mountain side with fewer animals than would be required to pack it. At the Wedge mine, near Marysvale, Utah, ore was dragged 2-1/2 miles down a steep mountain side in the summer of 1933 at a contract price of $2.50 per ton. The drag consisted of the front part of the running gear of a wagon with two trailing poles; it was pulled by two horses. The team and load were handled by two men. Two trips were made daily with two tons to the load. The ore was then loaded into a truck and taken to the railroad, seven miles distant, for $2.50 per ton. Up freight from the railroad to the mine cost $15 per ton.

Toboggans pulled by horses, rather than packing, are used in deep snow in some localities. In the spring of 1933 freight was being taken from Mountain Home to Atlanta, Idaho, 54 miles by truck, 10 miles by sleigh, 8 miles by toboggan over the summit covered with deep snow, and the final 8 miles by sleigh. Two men with two horses took two toboggan loads of 1,400 pounds each over the mountain. The contract price for the whole distance was $60 per ton.

At the Gold Bug mine, in 1934, on a branch of Rock Creek near Clinton, Mont., ore was dragged down a trail in a stone boat with one horse for a distance of 3,750 feet. The drop in elevation was about 1,000 feet. A load of 1,500 pounds was hauled in summer and one ton in winter. The boat was braked by a contrivance that dug into the ground. Three round trips were made per day. With labor at $4, and $1 per day for the horses, the cost in the summer was $2.22 per ton and $1.67 per ton in winter. Although packing probably would have been cheaper, no pack animals were available; only about 20 tons were taken down monthly.

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TABLE 7. - Costs of packing ore

Place	Distance one way, miles	Trips daily	Tons, daily	Kind of animals	Number of animals per ton	Condition of trail	Drop in elevation, feet	Year	Cost per ton	Cost per ton mile	Remarks
Dos Cabesos, Ariz.	2	3	.....	Burros	7	Fair	1,000	1934	$1.50	$0.75	Contract.
Do...............	1	5	5	do.	7	do.	700	1935	1.00	1.00	do.
Ruby, Ariz........	5	1	.....	do.	8	do.	.....	1935	3.50	.70	do.
Wickenburg, Ariz..	1	5	4	do.	7	Poor.	1,000	1935	3.00	3.00	Company account; 10 burros, 2 men on horses.
Superior, Ariz....	½ to 1½	....	25	do.	......	Fair.	800	1934	1.00 to 1.50	1.00 to 2.00	Contract.
Prescott, Ariz....	3/4	5	.....	do.	......	Steep	.....	1934	1.25	1.66	do.
Do...............	1-1/4	3	3	do.	8	do.	1,000	1934	2.00	1.60	do.
Camp Bird, Colo...	3	2	a/10	Mules	5 to 6	Good	1,500	1934	b/	....	28 to 30 mules, 2 horses, and 2 men. Contract.
Questa, New Mex...	1/4	....	.....	Burros	......	Fair	300	1930	1.00 to 1.50	4.00 to 6.00	Contract.

a/ Concentrate.

b/ Cost $6 per ton included with six mile wagon haul; up freight, $8 per ton.

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Costs of Packing

Packing usually is done cheaper by contract than on company account. This form of transportation generally costs less in the Southwest, where burros are plentiful, than elsewhere in the West. Many of the native Mexican farmers or small ranchers in the Southwest have a number of these animals and frequently are glad to take contracts for packing ore in the vicinity of their homes. The contractor usually walks and thus saves the expense of feeding a saddle horse, which he would demand if working on company account; moreover, he seldom buys feed for his animals for relatively short trips. He usually has a few extra animals to replace those showing the effect of hard work.

Costs of packing, the size of loads carried, and distances covered at nine mines are shown in table 7.

Summary of Costs

Packing costs generally are considered to be about $1 per ton-mile for moderate distances. Although lower contract prices are in effect in the Southwest, $1 per ton-mile appears low for most localities. For example, a man with 7 burros carrying a ton to the trip can make five 1-mile trips per day; at $1 per ton, his total gross earning is $5 per day. Should he be paid the usual mine surface scale ($45 per day) and the burros be fed and shod ($0.50 per day per animal), the cost would be $1.50 per ton-mile without considering the cost or replacement of the animals.

For short trips (1/2 mile or less) the cost per ton-mile is high, as most of the time is consumed in loading and unloading the animals. For longer trips less time is taken for loading but the loads are lighter.

A fair contract price for packing with burros over fair trails may be summarized as follows:

1/2 mile.........	$2.00
1 mile...........	1.50
2 miles..........	1.00

The cost of packing with mules will average 25 to 50 percent higher.